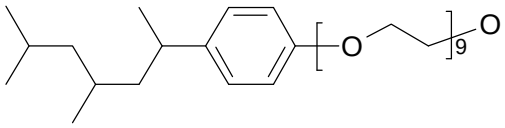
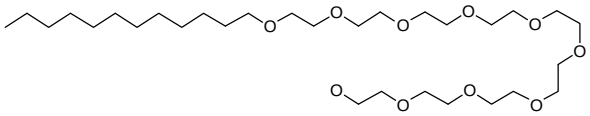
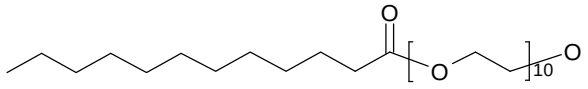
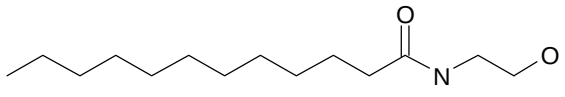
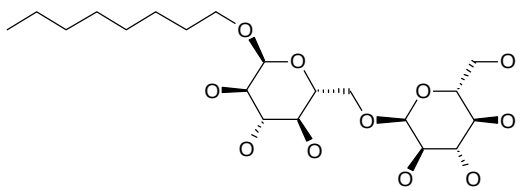
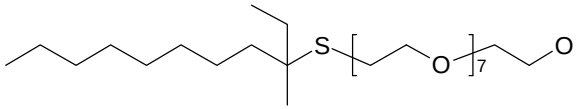
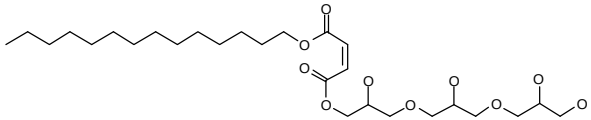
US EPA Design for the Environment Formulator Initiative

Category: Nonionic Surfactants
Positive Environmental Profile: Rapid degradation to non-toxic byproducts.

Selected Properties for Representative Nonionic Surfactants [a]

Name CAS Number	Structure	cmc,[b] mg/L	HLB[c]	Aquatic concern conc.,[d] ppm	Biodeg.[e] Rate Primary Ultimate	Biodegradation Products and Comments
Nonylphenol ethoxylate (9.5 EO) 9016-45-9		41[f]	12.9	0.001	days-weeks months-longer	Typical alkylphenol ethoxylate (APE). Degradation products such as nonylphenol are more toxic and more persistent than the parent.
Alcohols, C12-16, ethoxylated (9 EO) 68551-12-2		36-83[g]	13.4	0.02	days-weeks weeks-months	Products are less toxic than the parent. More positive environmental profile (EP).
Fatty acids, coco-, ethoxylated 61791-29-5			13.0-13.5	0.040	days weeks	Products are less toxic than the parent. Rapid hydrolysis of the ester destroys surfactant properties. More positive EP.

a. By nature, surfactants are often toxic to aquatic organisms because the properties that improve surfactancy also tend to increase toxicity. Surfactants with positive environmental profiles degrade rapidly to non-toxic products. For example, surfactants with ester linkages connecting the hydrophobic and hydrophilic groups are degraded by hydrolysis to yield non-surfactant products that are typically less toxic than the parent compounds.

Name CAS Number	Structure	cmc,[b] mg/L	HLB[c]	Aquatic concern conc.,[d] ppm	Biodeg.[e] Rate Primary Ultimate	Biodegradation Products and Comments
Dodecanamide, N-(2-hydroxyethyl) 142-78-9				0.040	days weeks	Used as a foamer. Products are less toxic than the parent. Significant hydrolysis to ethanolamine not expected. More positive EP.
D-Glucopyranose, oligomeric, decyl octyl glycosides 68515-73-1		4800-7300[f]	13	0.47	hours-days days-weeks	Low surfactant toxicity. Products are less toxic than the parent. More positive EP.
tert-Dodecanol, ethoxylated 9004-83-5			12.7	0.040	days-weeks weeks-months	Although biodegradation is hindered at the site of branching, products are less toxic than the parent. More positive EP than APEs.
Oxiranemethanol, homopolymer, (Z)-tetradecyl 2-butenedioate 183073-13-4		8.7[h]		0.006	hours-days weeks	Products are less toxic than the parent. Rapid hydrolysis of the ester destroys surfactant properties. More positive EP. Not commercialized.

b. The cmc is the critical micelle concentration. In general, surfactants must be present in amounts higher than the cmc to be effective detergents.

c. The HLB is the hydrophile-lipophile balance. This quantity is used to describe the hydrophilic character of a surfactant. The higher the HLB, the more hydrophilic it is.

d. Concern concentrations were determined from measured or estimated aquatic toxicity data according to standard EPA protocols. Estimations were based on structure activity relationships and nearest analog data.

e. Qualitative biodegradation half-lives were estimated using the BIOWIN program, which is included in the Estimation Programs Interface developed by Syracuse Research Corporation.

f. The cmc for this material is reported on its product data sheet found at Huntsman Corporation's website, www.huntsman.com.

g. The cmcs for these materials are reported in the December 1997 ABRF detergent table, located at www.abrf.org/ABRFNews/1997/December1997/dec97Table.html.

h. Klopotek, B.B.; Kijenski, J. *Tenside Surf. Det.*, **1997**, *34*, 174-177.